CF-18 AIRCRAFT CREWSTATION DEMONSTRATOR SYSTEM UPGRADE

FINAL REPORT

Contract Report CR 2003-037
CMC Document Number 1000-1291

6 January 2003/le 6 janvier 2003

RAPPORT FINAL SUR LA MODERNISATION DU SYSTÈME DÉMONSTRATEUR DE POSTE D'ÉQUIPAGE DE L'AÉRONEF CF-18

National Defence Défense nationale

Canada

Human Engineering Analysis and Requirements Tools
Technical Investigation and Engineering Services

HEART TIES Program

CF-18 AIRCRAFT CREWSTATION DEMONSTRATOR SYSTEM UPGRADE

Final Report

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Contract No. W8485-0-XKCF/01BQ
Requisition Number TI-04

HEART TIES TI-04

CF-18 Aircraft Crewstation Demonstrator (ACD) System Upgrade

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CMC Document Number 1000-1291
Contract No. W8485-0-XKCF/01BQ
Requisition Number TI-04

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EXECUTIVE SUMMARY

In support of the Director of Air Requirements/DAR 5, and the CF-18 Incremental Modernization Programme, the Human Systems Modelling Group (HSMG) at Defence Research and Development Canada - Toronto will perform a comparison between the Joint Helmet Mounted Cueing System (JHMCS) and the New Generation Helmet (NGH). Important human factors questions need to be answered, including "How would these new displays affect the pilot's situational awareness since the attentional demands have been shifted or changed?"

The CF-18 Aircraft Crewstation Demonstrator (ACD) is a virtual environment developed for DRDC Toronto by CMC Electronics to study CF18 acquisition issues and has been used by CMC Electronics to study the use of new colour DDI displays in an air-to-air role. The CF18 ACD will be used to carry out the next set of human factors experiments that are intended to answer the Helmet Mounted Display system questions noted above. This type of simulation and study provides project managers with tools to rapidly evaluate different options, assessing designs for potential problems before costly prototype models are built and supplementing expert opinion and analytical data with objective, operationally relevant data.

Preliminary testing of the CF18 ACD configuration against the required experimental protocol revealed a series of integration, software, and operating system problems that require intimate knowledge of the ACD software.

Consequently, the HEART TIES Team was contracted to assist in troubleshooting, error correcting, programming, and test and evaluation of the CF-18 ACD to enable it to support the the planned Helmet Mounted Display studies. This report documents the work done by the HEART TIES Team to resolve the current software problems and provide an overall improvement in system performance and reliability.

SOMMAIRE À L'INTENTION DE LA DIRECTION

En appui au Directeur – Besoin en ressources aériennes/ DBRA 5 et au programme de modernisation graduelle du CF-18, le groupe de modélisation des systèmes humains de Recherche et développement pour la Défense Canada – Toronto comparera le système de repérage mixte monté sur casque et le casque de la nouvelle génération. Des questions importantes sur les facteurs humains devront être répondues , dont « Quelle serait l'incidence de ces dispositifs d'affichage sur la connaissance de la situation qu'a le pilote, étant donné que les demandes attentionelles ont changé? »

Le démonstrateur de poste d'équipage (DPE) de CF-18 est un environnement virtuel développé pour RDDC Toronto par CMC Électronique pour permettre l'étude des questions d'acquisition liées au CF-18, et est utilisé par CMC Électronique pour étudier l'utilisation de nouveaux indicateurs à affichage numérique couleurs en situation air-air. Le DPE de CF-18 sera utilisé lors des prochaines expériences sur les facteurs humains visant à répondre aux questions relative à la visualisaton de casque. Ces études et simulations fournissent aux gestionnaires de projets les outils pour évaluer rapidement les différentes options, trouver dans les conceptions des problèmes potentiels avant que des prototypes onéreux ne soient construits et compléter les avis d'experts et les données analytiques avec des données opérationelles pertinentes et objectives.

Les tests préliminaires de la configuration du DPE de CF-18 menésselon le protocole d'expérimentation requis ont permis de relever une série de problèmes d'intégration, de logiciel et de système d'exploitation dont la situation nécéssite une connaissance approfondie du logiciel du démonstrateur.

En conséquence, l'équipe HEART TIES a reçu le mandat d'aider au dépannage, à la correction des erreurs, à la programmation, au test et à l'évaluation du DPE de CF-18 afin qu'il puisse servir aux études prévues sur la visualisation de casque. Ce rapport documente les travaux effectués par l'équipe HEART TIES pour résoudre les problèmes de logiciel actuels et améliorer de façon générale les performances et la fiabilité du système.

ABSTRACT

DRDC Toronto has contracted the HEART TIES Team to assist in troubleshooting, error correcting, programming, and test and evaluation of the CF-18 Aircraft Crewstation Demonstrator for a Helmet Mounted Display study. Several deficiencies in the apparatus had been identified and on-site support was desired for a preliminary evaluation of the simulation by staff from the Directorate of Air Requirements. The software problems were corrected as well as several additional problems that were identified during the evaluation; the remaining problems were minor and DRDC staff would correct them after the evaluation.

RESUMÉ

RDDC Toronto a donné à l'équipe HEART TIES le mandat d'aider au dépannage, à la correction des erreurs, à la programmation, au test et à l'évaluation du démonstrateur de poste d'équipage de l'aéronef CF-18 pour une étude sur la visualisation de casque. Plusieurs lacunes dans l'appareil ont été relevées et un soutien sur place était sollicitépour une évaluation préliminaire de la simulation par le personnel du Directeur - Besoins en ressources aériennes. Les problèmes de logiciel ont été corrigé, de même que d'autres problèmes additionnels relevés lors de l'évaluation. Les problèmes restants sont mineurs, et le personnel de RDDC les corrigera après l'évaluation.

REVISION PAGE

REVISION LETTER	PAGES AFFECTED	DATE	APPROVAL

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SECTION ONE – INTRODUCTION

1.1 GENERAL

The Department of National Defence (**DND**) has contracted the HEART TIES Team to assist in troubleshooting, error correcting, programming, and test and evaluation of the CF-18 Aircraft Crewstation Demonstrator (**ACD**) for the Helmet Mounted Display (**HMD**) study to be performed at DRDC-Toronto.

1.2 BACKGROUND

In support of the Director of Air requirements (DAR) 5 and the CF-18 Incremental Modernisation Programme (IMP), the Human Systems Modelling Group (HSMG) will perform a comparison between the Joint Helmet Mounted Cueing System (JHMCS) and the New Generation Helmet (NGH). A significant difference between the two systems is that NGH supports raster imagery on the visor. This means that Forward Looking InfraRed (FLIR) imagery can potentially be displayed on the visor of the HMD. The primary Human Factors question is, "how would this new display affect the pilot's situational awareness since the attentional demands have been shifted or changed?"

The CF-18 ACD is the virtual environment chosen to carry out the experiment. Four contracts have been evoked to help re-configure the facility according to the experimental protocol. Preliminary testing of the configuration against the protocol revealed a series of integration, software, and operating system problems that require intimate knowledge of the ACD software programs and expertise in IRIX operating systems. The intent of this contract is to finally resolve the current problems with the system configuration as well as those that arise during this testing phase. The changes made to the CF-18 ACD must be implemented such that they will be applicable to future experiments.

1.3 AIM

The aim of this project is to prepare the CF-18 ACD to support the next set of Human Factors experiments.

1.4 REFERENCES

1. DRDC-Toronto Statement of Work for Programming Assistance for CF18 Aircraft Crewstation Demonstrator, dated 02 Aug 2002.

SECTION TWO - PROJECT OVERVIEW

2.1 GENERAL

A number of specific problems with the existing ACD software were identified by DRDC-Toronto personnel. In addition, DRDC-Toronto requested programming support during a systems acceptance and verification period prior to the beginning of experimentation. The following sections outline the work that was required to be performed.

2.2 VERIFY CORRECT FUNCTIONALITY OF SIM12

The SIM12 (ONYX 3200) computing platform is currently undergoing warranty repair work associated with one of the two graphics pipes installed on the system. This repair work is the result of a diagnostic process undertaken by DRDC-Toronto to resolve system instabilities. Following the conduct of repairs on the SIM12 system, assistance will be provided to verify the correct functionality of the system.

2.3 TROUBLESHOOT DESIGNATE ROUTINE

A Forward Looking Infra-Red (FLIR) simulation module was developed and installed in the ACD. A number of problems have recently been identified that need to be resolved to continue effective use of this module. This task will analyze the problems and develop the required fixes so that the module can function correctly.

2.4 INTEGRATE WAYPOINT MODULE.

A waypoint module was developed for the Flight Management System (FMS) and subsequently activated with the system. However, a number of problems have been identified that required resolution for the module to work correctly. This task will analyze the problem and develop the required fixes to the module.

2.5 ADJUST DIGITAL DISPLAY INDICATOR

One of the DDIs used in the ACD is used to display FLIR imagery from the FLIR simulation module. While the FLIR imagery is displayed correctly, problems have been identified with the overlay information. This task will determine the problems with the overlays and implement the required fix.

2.6 PROVIDE TEST SUPPORT

Additional support will be provided to DRDC-Toronto to assist in testing and debugging activities. These activities will support the confirmation of correct functionality of the CF-18 ACD.

SECTION THREE – SUMMARY OF WORK COMPLETED

3.1 GENERAL

The following sections summarize the work completed to support the upgrades to the CF-18 ACD and to address the specific issues identified in the previous section.

3.2 VERIFY CORRECT FUNCTIONALITY OF SIM12

Upon arrival at DRDC-Toronto, it was apparent that a majority of work had been completed on SIM12, including a reinstallation of the operating system by DRDC-Toronto personnel. It was assumed that this would remedy any continuing stability problems with the computer. Upon instruction from DRDC-Toronto personnel, work began immediately on other work items, with the understanding that any additional problems with SIM12 would be noted as they occurred. For the most part the system was stable; however, at one time, the computer stopped responding, and then rebooted itself. As no work was taking place on the system at the time, it was not possible to establish what caused this instability. Otherwise, the system appeared to be stable.

3.3 TROUBLESHOOT DESIGNATE ROUTINE

The Designate routine was rewritten to take advantage of facilities in Vega to handle an observer being point-stabilized on a predetermined spot. The existing code was broken up in to separate designate and undesignated routines, increasing the modularity of the application. The changes made remedied the defects noticed in the existing module.

3.4 INTEGRATE WAYPOINT MODULE

The FMS had an existing waypoint module; however this module had never been used and difficulties were encountered integrating it successfully with other portions of the system, including the scenario framework application, and the out-the-window scene application. The original FMS waypoint system was designed to manipulate FLSIM waypoint structures. It was identified that this was not required for the current experiment, as only one waypoint was desired, which would mark the region in which the target was located. Rather than modify the existing FMS, new code was added to the out-the-window scene application to handle receipt of messages identifying waypoints from the scenario framework application, and to store this information in an array. An update function was installed to handle calculation of bearing and range to the current waypoint. At this point, it became obvious that the HUD symbology set was designed to accept bearing information in a different format than was being passed from the scene application. As a result, the correct format was identified and then implemented accordingly.

3.5 ADJUST DIGITAL DISPLAY INDICATOR

Although the SOW only identified one deficiency with the FLIR DDI, several problems were identified and corrected.

The DDI has a screen size of 640x480 pixels, with a region of approximately 480x480 visible to the cockpit. Due to the bezel panel surrounding the DDI, the area visible from the pilot's seat is in the middle of the DDI. The Vega ADF file was modified so that the channel corresponding to the FLIR was resized to be 480x480 pixels. This channel was then placed on the DDI window so that it was visible from the pilot's seat.

Several modifications were made to the FLIR symbology overlay code. First, the call to GlViewport was removed so that the viewport remained in the state established when the FLIR visuals were drawn, removing the need to manually adjust the viewport to correspond to the FLIR window. This resolved the problems with the overlay position.

In addition, problems would periodically occur with the font used to display information on the FLIR overlay. It would become extremely thick and illegible. A call to GlLineSmooth was removed from the symbology code, and the problem was resolved.

3.6 PROVIDE TEST SUPPORT

Programming support was required during a testing and acceptance phase for the ACD prior to experimentation. It was desired to maximize pilot time in the cockpit, and so support was limited for the most part to small fixes. A number of deficiencies were noted, summarized in the following list. Those marked with an asterisk (*) were fixed while on site.

Size of font used for HUD heading tape was incorrect.

Size of HUD waypoint marker was incorrect.

Crosshair on the FLIR was improperly shaped. (*)

Rudder was non-functional.

Position of FLIR pod on the aircraft was incorrect.

Field of Regard of the FLIR was too large. (*)

FLIR slew rate was too quick. (*)

There should not be any buildings next to the runway.

Stick controls were to sensitive overall, and non-linear in the lateral direction.

A reference line would make tracker calibration much easier.

There was a lot of latency in the head tracker.

HUD intensity relative to the out-the-window scene should be increased to aid reading the symbols.

A boresight button for the FLIR would be helpful.

A decimal point was missing in range to target on HUD display. (*)

TTG on the FLIR displays 10004 and when moving away from the target.

On the altitude display in the HUD, the hundreds, tens and units digits should only appear in the smaller font if above 9999 metres.

Azimuth steering line was visible when proceeding away from target but not while proceeding towards target.

Experimental scenario of searching for target with FLIR was unrealistic in terms of operational procedures. The field of regard of the FLIR is too small for this to be practical. It was recommended that the FLIR begin designated on one target and then during the mission direct the pilot search for another target close to the site of the first.

Threats appeared sometimes as grey rather than white.

SECTION FOUR - CONCLUDING MATERIAL

4.1 CONCLUSIONS

The work was completed in accordance to the requirements, within the limits of this program. Although the work under contract was completed, several items were identified during pilot testing that would potentially prevent the experimentation scenarios from being run successfully. This was discussed with DRDC-Toronto personnel and the issues identified require adjustments and bug fixes, rather than substantial amounts of new development. As a result, this additional work will be completed, as required, by DRDC-Toronto personnel.

During pilot testing, it was not possible to test bomb release due to problems with the Azimuth Steering Line (ASL). Otherwise, the testing performed was comprehensive, and the device, once the deficiencies detailed above are remedied, will be ready for experimentation.

ANNEX A

GLOSSARY OF TERMS AND ACRONYMS

ANNEX A - GLOSSARY OF TERMS AND ACRONYMS

ACD	Aircraft Crewstation Demonstrator
AFOTEC	Air Force Operational Test and Evaluation Center
CDU	Control Display Unit
CFB	Canadian Forces Base
CMC	Canadian Marconi Company
DCIEM	Defence and Civil Institute of Environmental Medicine
DND	Department of National Defence
DTS	Data Transfer System
HFE	Human Factors Engineering
HSI	Horizontal Situation Indicator
LATEF	Land Aviation Test and Evaluation Flight
MIL-HDBK	MILitary HanDBooK
MIL-STD	MILitary STandarD
PC	Personal Computer
PMO	Project Management Office
SIL	Systems Integration Laboratory
SME	Subject Matter Expert
SUE	Software Usability Evaluator

DOCUMENT CONTROL DATA SHEET

1a. PERFORMING AGENCY
CMC Electronics, 415 Legget Drive, Box 13330, Kanata, ON, K2K 2B

2. SECURITY CLASSIFICATION
UNCLASSIFIED
Unlimited distribution -

1b. PUBLISHING AGENCY
DRDC Toronto

3. TITLE
(U) CF-18 AIRCRAFT CREWSTATION DEMONSTRATOR SYSTEM UPGRADE FINAL REPORT

4. AUTHORS
D.Minor

5. DATE OF PUBLICATION
March 1 , 2003

6. NO. OF PAGES
15

7. DESCRIPTIVE NOTES

8. SPONSORING/MONITORING/CONTRACTING/TASKING AGENCY
Sponsoring Agency:
Monitoring Agency:
Contracting Agency : DRDC Toronto
Tasking Agency:

9. ORIGINATORS DOCUMENT NO.
Contract Report CR 2003-037

10. CONTRACT GRANT AND/OR PROJECT NO.
W8485-0-XKCF/01BQ-04

11. OTHER DOCUMENT NOS.
CMC Document Number 1000-1291

12. DOCUMENT RELEASABILITY
Unlimited distribution

13. DOCUMENT ANNOUNCEMENT

14. ABSTRACT

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15. KEYWORDS, DESCRIPTORS or IDENTIFIERS

(U) CF18 ACD;simulator

#520133
CA023057

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